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AUSTRALIAN CARABID BEETLES IX. THE TROPICAL *NOTONOMUS*

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This is the last of four papers on flightless Carabidae of zoogeographic importance from tropical eastern Australia—but these papers are part of my general series on Australian carabid beetles, which will be continued. Pertinent earlier parts of the series, including a locality list (with maps) and a discussion of the transition of wet forest carabid faunas from New Guinea to Tasmania, are listed with references at the end of the present paper. Information on deposition of types will be found at the beginning of Part VI (1961c). In this as in other parts of this series, proportions stated as simple fractions are based on actual measurements made with a ruled ocular in the microscope.

The present paper concerns the tropical species of the dominant eastern Australian pterostichine genus *Notonomus*. The genus as a whole ranges along the eastern edge of Australia from the base of the Cape York Peninsula (somewhere between Daintree and Cooktown) to Victoria and Tasmania in the south, extending west into the eastern edge of South Australia, with one very distinct species geographically isolated in southwestern Australia and two species described from New Caledonia. I have dealt with some of the tropical Australian species before (1953) but several additional species are now to be described and a new key is necessary.

The tropical species of *Notonomus* are all apparently related among themselves and form what may be called the *doddi* subgroup of Sloane's (1913) *kingi* group of the genus. The *doddi* subgroup is characterized by posterior-lateral setigerous punctures of pronotum on (not inside) thickened margin at basal angles; elytra fully and strongly striate; 3rd interval not more than (but sometimes less than) 2-punctate (except that rarely

individuals have extra adventitious punctures) and 5th and 7th intervals impunctate; 8th interval (10th in *saepistriatus*) narrow and convex (least so in *masculinus*); metepisterna short; intercoxal declivity of prosternum flat, without setae; tarsi not striolate above; posterior tarsi with 1st segment rather long (but not quite so long as next 2 together) and with claw segment glabrous below; and ♂ with 1, ♀ usually 2 setae each side last ventral segment (1 seta each side in ♀ *montellus*, and single anal setae may be either missing or duplicated in individuals of other species), and ♂ with anterior tarsi dilated with 3 segments squamulose below, ♀ usually with tarsi unmodified (but some [not all] ♀♀ of *doddi*, *flos*, *montorum*, and *masculinus* have front tarsi with 1st segment squamulose). Other characters common to all members of the *doddi* subgroup, and therefore not repeated in the following brief descriptions, are: prothorax with apex subtruncate or broadly emarginate with angles not or not much advanced beyond arc of emargination, margined at sides but not at middle; base slightly sinuously subtruncate, margined only at sides; side margins rather narrow, only slightly wider posteriorly; disc with middle line nearly entire, transverse impressions weak or obsolete, baso-lateral impressions long, linear, moderately impressed, not punctate; elytra with basal margin c. rectangular at finely subdenteate humeri; narrow extra (10th, or 12th in *saepistriatus*) submarginal interval present at least posteriorly. Although they agree in these characters (with exceptions noted), the species of the *doddi* subgroup differ remarkably among themselves in some other characters, given in the following key.

EXPLANATION OF MAP ON PAGE 3

Known distribution of *Notonomus* in tropical Queensland. The finely dotted line is the approximate eastern edge of high land (the Atherton Tableland etc.). No. 1 (arrow) indicates occurrence of *Notonomus transitus* endemic on the Eungella Range south of the limits of the map; 2, *N. doddi* in the Herberton-Atherton area, and also (arrow) south of the limits of the map on the Kirrama Range, the Mt. Fox plateau, and the Mt. Spec plateau; 3, *montellus*; 4, *dimorphicus*; 5, *spurgeoni*; 6, *flos*; 7, *montorum* with subspecies *azul* on Mt. B(ellenden) K(er); 8 (arrow) *elliati*, endemic on the Elliot Range south of Townsville, beyond limits of map; 9, *masculinus*; 10, *saepistriatus*. Note the wide gap between the Atherton Tableland species and those on the mountains of the Mossman-Daintree area; the 3 species on the latter mountains are apparently derived from one secondary ancestor.

Distribution of tropical *Notonomus*.

So far as I know, all the tropical *Notonomus* are confined to rain forest, and they *may* all be derived from a single primary ancestor that invaded tropical rain forest from the more southern part of eastern Australia. *N. transitus*, on the Eungella Range in east-central Queensland, may be a (presumably modified) derivative of this ancestor. Of the more northern species (see map), *doddi* of the Dividing Range system from Mt. Spec to Atherton, and *montellus* of Mts. Bartle Frere and Bellenden Ker, may be related to each other; *montorum*, of Mts. Bartle Frere and Bellenden Ker, and *ellioti*, of the Elliot Range south of Townsville, may be relicts of one more widely distributed secondary ancestor; *masculinus* and *saepistriatus*, with allopatric ranges on the Atherton Tableland, may be related to each other in spite of their structural differences; and the three species north of the Atherton Tableland (*dimorphicus*, *flos*, *spurgeoni*) may be interrelated and may now be in process of radiation from one secondary ancestor. All this suggests the probable complexity of evolution of the group in the rain forests of North Queensland, especially on and near the Atherton Tableland. The radiation of *Trichosternus* in the same area (Darlington 1961d) may have been even more complex. Incidentally, no species of either *Notonomus* or *Trichosternus* has yet been found on the heavily rain-forested mountains that lie on the northern part of the Atherton Tableland between the Yungaburra-Lake Barrine road (on the south) and the Mareeba-Kuranda road (on the north), although these mountains are the home of a striking endemic *Leiradira* (*aurifer* Darlington 1961e).

Key to tropical species of NOTONOMUS (doddi subgroup)

1. Species with *all* following characters: elytral striae not widened on disc, and intervals normal in number and not much interrupted, and 3rd interval with dorsal punctures 2
- *Either* striae wide and opaque on disc (not just on declivity), *and/or* intervals more numerous or much interrupted, *and/or* 3rd interval without dorsal punctures 7
2. Sides of ventral segments 4-6 extensively punctate (more so than 1st ventral); (dull black, pronotum virtually smooth) *transitus*
- Ventral segments not punctate or, if punctate, 1st most strongly so 3
3. Pronotum deeply and closely transversely strigulose 4
- Pronotum only normally (lightly or faintly) transversely strigulose 5
4. Brownish black, usually larger (12.5-16 mm.); ♀ with 2 setae each side last ventral segment *doddi*

- Bluish or purplish; usually smaller (10.5-13 mm.); ♀ with 1 seta each side last ventral *montellus*
- 5. Male slender (Fig. 3) (♀ less so); (bicolored) *dimorphicus*
- Both sexes stouter 6
- 6. Wholly purplish or bluish; length c. 12-17 mm. *spurgeoni*
- Bicolored, head and pronotum purple or coppery, elytra black; broader and larger, length c. 16-20 mm. *flos*
- 7. Elytral intervals not much interrupted (3rd without dorsal punctures) 8
- Elytral intervals much interrupted (3rd with or without dorsal punctures) 9
- 8. Form broader; dull *montorum*
 - a. Greenish or purplish *montorum*, *sensu stricto*
 - b. Bluish with elytral margins bright blue subsp. *azul*
- Form narrower; more shining, purplish *elliotti*
- 9. Elytron with 9 intervals, without dorsal punctures *masculinus*
- Elytron with 11 intervals plus narrow submarginal one posteriorly (7th interval tripled), and with dorsal punctures *saepistriatus*

NOTONOMUS TRANSITUS n. sp.

With characters of *doddi* subgroup; form as figured (Fig. 1), rather broad and depressed (in group); black, upper surface sometimes slightly aeneous, marginal channels of elytra usually cupreous or dull greenish; most of upper surface with fine isodiametric microsculpture. *Head* $\frac{2}{3}$ or slightly less width prothorax, without noticeable unusual characters. *Prothorax* c. $\frac{1}{4}$ or less wider than long; sides weakly arcuate for most of length, slightly sinuate almost at base; basal angles slightly obtuse, not much blunted; disc smoother than usual, with transverse strigulation very faint or absent. *Elytra* slightly less than $\frac{1}{5}$ wider than prothorax; striae rather fine, not punctate, not widened even on declivity; intervals nearly flat on disc, more convex laterally, the discal ones subequal; 3rd interval 2-punctate, behind middle and behind apical $\frac{3}{4}$. Lower surface nearly impunctate anteriorly but much of abdomen finely and closely but rather irregularly punctate. Secondary sexual characters normal; all ♀♀ (16) with simple anterior tarsi. Length c. 13-18; width 4.5-6.1 mm.

Holotype ♂ (M.C.Z. Type No. 30,387) and 26 paratypes all from the Eungella Range, west of Mackay, east-central Queensland, 2000-3000 ft. altitude, Nov. 1957, taken by the Darlingtons, in rain forest.

Superficially, *transitus* is similar to the common, variable *N. nitidicollis* Chaudoir of South Queensland. There may be a real relationship between these two species. However, *transitus* leads toward the North Queensland species of the genus in position of the posterior-lateral prothoracic setae, on the thickened margin (inside the margin in *nitidicollis*), and it differs from *nitidicollis* in other specific characters. For example, *transitus* is broader and more depressed, with flatter elytral intervals than *nitidicollis*, and the extensive punctation of the abdomen of *transitus* is lacking in *nitidicollis*. The northern limit of *nitidicollis*, incidentally, is probably Mt. Jacob, about 45 miles south of Gladstone, South Queensland. Of the North Queensland species, *transitus* is probably nearest *doddi* but differs in being broader and more depressed, with flatter elytral intervals, without special pronotal sculpture, but with abdominal punctation.

NOTONOMUS DODDI Sloane

The type locality is the Herberton District, Atherton Tableland, North Queensland (Sloane 1913, p. 439). Specimens that I collected on the mountains south and west of Atherton (between Atherton and Herberton) are virtually topotypes. The species extends south (discontinuously) along the Dividing Range system to the Kirrama Range, the Mt. Fox plateau, and the Mt. Spec plateau not far north of Townsville.

The exceptionally close and deep transverse strigulation of the pronotum is apparently always present in this species, but the other pronotal mierosculpture is dimorphic. Most individuals have the head very finely and the elytra more coarsely (but still finely) isodiametrically reticulate and the pronotum *longitudinally* roughened between the deep transverse strigae. However, my series of 11 specimens from the Mt. Spec plateau includes 3 ♂♂ with pronotum without longitudinal roughening, although the 4 other ♂♂ and all 4 ♀♀ have the roughening present, as do all specimens from other localities. The length of this species is c. 12.5-16.5 mm., with the average size decreasing southward.

NOTONOMUS MONTELLUS n. sp.

With characters of *doddi* subgroup as given above; form as figured (Fig. 2), small, slightly depressed; bluish or purplish black; head and elytra with fine isodiametric mierosculpture, less distinct on pronotum. Head $\frac{2}{3}$ or slightly less width prothorax, without obvious unusual characters. Prothorax $\frac{1}{5}$ (\pm)

wider than long; sides broadly arcuate for most of length, briefly sinuate before c. right, scarcely blunted basal angles; main (central) part of disc with many deeply impressed, close-spaced, slightly irregular, transverse strigae; surface of disc otherwise not distinctly punctate. *Elytra* $\frac{1}{4}$ (\pm) wider than prothorax; striae well impressed, not punctate, not or scarcely widened even on declivity; intervals moderately convex, subequal on disc; 3rd 2-punctate near middle and apical $\frac{1}{4}$ (punctures slightly variable in position). Lower surface with a little scattered (variable) punctuation especially on sides of mesosternum and 1st ventral segment. Secondary sexual characters normal except ♀ with 1 seta (not 2) each side last ventral segment. Length c. 10.5-13.0; width 3.5-4.4 mm.

Holotype ♂ (M.C.Z. Type No. 30,388) and 5 ♂♂ 4 ♀♀ paratypes from Mt. Bartle Frere, west slope, 3000-5000 ft., Dec. 1957; and 1 additional ♀ (not a type) from Mt. Bellenden Ker, east side, about 4500 ft., Dec. 1957. These two mountains are close together at the east side of the Atherton Tableland, south of Cairns, North Queensland. Specimens all taken by the Darlingtons, in mountain rain forest.

This small *Notonomus* is closest in technical characters to *N. doddi* Sloane, of the Dividing Range system, and may be related to it, but differs in smaller size, more depressed form, color, and presence of only 1 seta each side ♀ last ventral segment. The pronotal sculpture resembles that of the exceptional *doddi* from Mt. Spec, with deep transverse strigulation but without longitudinal roughening.

NOTONOMUS DIMORPHICUS n. sp.

With characters of *doddi* subgroup as given above; ♂ (Fig. 3) exceptionally slender, ♀ (Fig. 4) less so; head and prothorax aeneous, elytra purplish black; moderately shining with fine isodiametric microsculpture on head and elytra, not distinct on pronotum. Head c. $\frac{3}{4}$ or more width prothorax, without noticeable unusual characters. Prothorax slightly longer than wide in slender ♂♂, slightly wider than long in stouter ♀♀ (but slightly variable in both sexes); sides rather weakly rounded, in ♂♂ nearly straight and converging both before and behind submedian curve but more regularly arcuate in ♀♀; sides briefly, variably sinuate just before base; basal angles right or slightly obtuse, not much blunted; surface of disc with faint transverse strigae, not punctate. *Elytra* c. $\frac{1}{5}$ (\pm) wider than prothorax;

striae not widened except slightly so (striae 1 and 2) at extreme apex, on deelivity; intervals moderately convex, not interrupted, subequal on disc; 3rd 2-punctate, near middle and posteriorly (middle puncture sometimes duplicated). Lower surfaces nearly impunctate. Secondary sexual characters (other than dimorphism of form) normal. Length *c.* 12-15; width 3.6-4.6 mm.

Holotype ♂ (M.C.Z. Type No. 30,389) and 7 ♂♂, 7 ♀♀ paratypes all from Mt. Lewis, near Mossman, North Queensland, *c.* 3000 ft., Dec. 1957, collected by the Darlingtons, in rain forest.

Males of this species are unique in form at least among the tropical species of the genus, and at first I thought they might represent transition toward *Leiradira*, but the mandibles, antennae, and setae of the inner edge of the maxilla are as usual in *Notonomus*. The ♀♀ are close to *N. spurgeoni* (below) but are more slender and bicolored. All specimens that I refer to the present species were taken within a comparatively small area of continuous mountain forest, and I feel sure they represent a single population. A single ♀ that I refer to *spurgeoni*, although labeled from Mt. Lewis, may have been taken outside of and below the area occupied by *dimorphicus*.

NOTONOMUS SPURGEONI Darlington

This is the most northern known species of *Notonomus*. I described it (1953, p. 98) from a series from Mt. Spurgeon, about 12 miles northwest of Mt. Lewis in the same mountain system. Three specimens from Thornton Peak, northeast of Daintree, near 4000 ft., Dec. 1957, taken by the Darlingtons in mountain rain forest, seem to be the same species, although the color is bluish rather than purplish. A single ♀ from Mt. Lewis is also apparently referable to this species (see note under *dimorphicus*, above).

NOTONOMUS FLOS n. sp.

With characters of *doddi* subgroup as given above; form as figured (Fig. 5), rather large and broad in group; black, head and pronotum bright violaceous or cupreous; moderately shining, elytra slightly duller; fine isodiametric microsculpture very distinct on elytra, absent or indistinct on head and pronotum. Head $\frac{2}{3}$ (\pm) width prothorax, without obvious unusual characters. Prothorax large, $\frac{1}{5}$ to $\frac{1}{3}$ wider than long; sides broadly areuate for almost entire length, usually minutely sinuate at base (the sinuation involves hardly more than widening of the marginal

bead); basal angles obtuse (sometimes nearly right); surface of disc with weak transverse strigae. *Elytra* slightly wider than prothorax; striae well impressed, not punctate, not or not much widened on disc but inner ones wider and dull on declivity; intervals convex, subequal on disc; 3rd 2-punctate near middle and posteriorly (exact position of punctures variable as usual). Lower surface nearly impunctate. Secondary sexual characters normal except some ♀♀ (2 of 4) with front tarsi with 1st segment squamulose below, although not dilated. Length c. 16-20; width 5.5-6.4 mm.

Holotype ♂ (M.C.Z. Type No. 30,390) and 17 paratypes (13 ♂♂, 4 ♀♀) all from Mt. Lewis, southwest of Mossman, North Queensland, c. 3000 ft., Dec. 1957, taken by the Darlings in mountain rain forest.

The comparatively large, broad form, color, and characters given in the key should easily distinguish this species. It was found with *dimorphicus* on Mt. Lewis, and the occurrence of *spurgeoni* too there or nearby raises an interesting problem of speciation. I think all 3 species have probably been derived from one ancestor, but I do not know how the divergence has come about.

NOTONOMUS MONTORUM n. sp.

With characters of *doddi* subgroup as given above; form as figured (Fig. 6), rather large, broad, and depressed in group; greenish or sometimes vaguely purplish with elytral margins usually greenish and never bright blue; rather dull, entire upper surface with very fine, isodiametric reticulate microsculpture. Head c. $\frac{2}{3}$ width prothorax, without noticeable unusual characters. Prothorax $\frac{1}{4}$ to $\frac{1}{3}$ wider than long; sides broadly arcuate for much of length, usually broadly but slightly sinuate posteriorly; basal angles usually subprominent, c. right, scarcely blunted; surface of disc with weak transverse strigulae. *Elytra* c. $\frac{1}{3}$ or more wider than prothorax; striae widened and opaque especially posteriorly; intervals moderately convex, subequal on disc; 3rd without dorsal punctures. Lower surface with sides of ventral segments (especially 1st) finely and irregularly punctate, but sterna nearly impunctate. Secondary sexual characters of ♂♂ and most ♀♀ normal, but exceptional ♀♀ with 1st segment front tarsi with squamae below. Length c. 15.5-19.5; width 5.2-6.9 mm.

Holotype ♂ (M.C.Z. Type No. 30,391) and 76 paratypes from Mt. Bartle Frere, west slope, 3000-5000 ft., Dec. 1957, and 12 additional paratypes with the same data except 2000-3500 ft. altitude; all specimens taken by the Darlingtons, in mountain rain forest. Mt. Bartle Frere is at the eastern side of the Atherton Tableland south of Cairns, North Queensland. A weak subspecies (below) occurs on neighboring Mt. Bellenden Ker.

See key for distinguishing characters of this species, and see also note under *elliotti* (below).

NOTONOMUS MONTORUM AZUL n. subsp.

Structurally similar to typical *montorum* (above) but more shining and different in color, bluish black with elytral margins bright blue in all specimens. Of 5 ♀♀, 1 has and 4 have not squamae on 1st segment of front tarsi. Length c. 16-19; width 5.3-6.6 mm.

Holotype ♂ (M.C.Z. Type No. 30,392) and 11 paratypes all from Mt. Bellenden Ker, east side, 3000-4500 ft., Jan. 1958, collected by myself in mountain rain forest. Mt. Bellenden Ker is about 10 miles north of Mt. Bartle Frere at the eastern edge of the Atherton Tableland south of Cairns, North Queensland.

NOTONOMUS ELLIOTI n. sp.

With characters of *doddi* subgroup as given above; form as figured (Fig. 7), narrower than *montorum*, moderately depressed; purplish black, rather shining; fine reticulate micro-sculpture present but lightly impressed on head and pronotum, slightly more distinct on elytra. Head $\frac{2}{3}$ or slightly less width prothorax, without noticeable unusual characters. Prothorax c. $\frac{1}{5}$ or slightly less wider than long; sides broadly, rather weakly areuate for most of length, then slightly sinuate near base; basal angles c. right, well defined; disc faintly, transversely strigulose (as in most species of genus). Elytra c. $\frac{1}{5}$ or less wider than prothorax; striae narrow anteriorly but widening on posterior part of disc and especially on declivity; intervals moderately convex, subequal on disc (odd ones slightly wider than even); 3rd without dorsal punctures. Lower surface almost impunctate. Secondary sexual characters normal in ♂; ♀ unknown. Length c. 16-18; width 5.0-6.0 mm.

Holotype ♂ (M.C.Z. Type No. 30,393) and 5 paratypes (all ♂♂) all from the Elliot Range (actually from near the summit

of "Sharp Elliot"), c. 3000 ft., Mar. 1958, taken by my son and myself in mountain rain forest.

This species may be related to *montorum* of Mts. Bartle Frere and Bellenden Ker. If so, the two mountain species are presumably relics of a once more widely distributed stock. As compared with *montorum*, the present species is more slender, with elytral striae narrower, especially anteriorly.

NOTONOMUS MASCULINUS Darlington

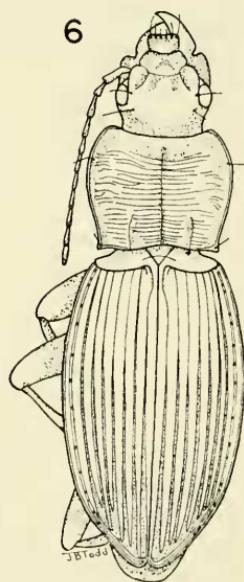
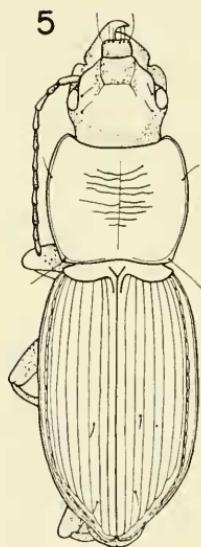
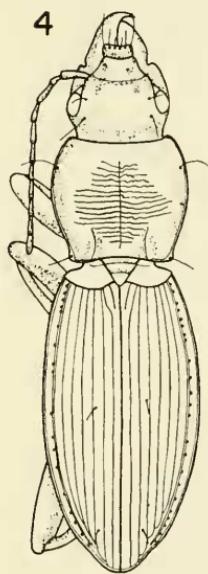
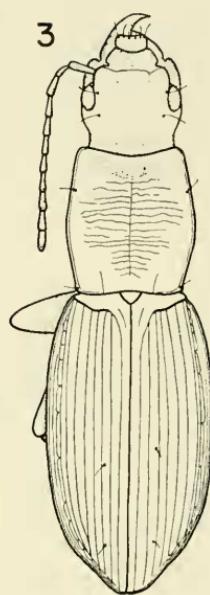
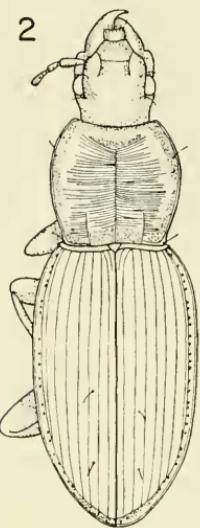
N. masculinus (Fig. 8) is a relatively large, broad species with elytral intervals normal in number but heavily catenulate (much interrupted) and without dorsal elytral punctures. It has an extensive distribution on the southern part of the Atherton Tableland. I described it (1953, p. 99) from Millaa Millaa, and other known localities are indicated below. I have noted elsewhere (1961c, p. 7) the resemblance between this species and *Pamborus punctatus*, and have suggested that it may be a case of mimetic convergence.

In ♂♂ of *masculinus* the front tarsi are moderately dilated, with three segments squamulose below. In some ♀♀ the front tarsi are normal (without squamae) but in others the front tarsi, though scarcely widened, have the 1st segment biseriately squamulose. My single ♀ from Millaa Millaa has the front tarsi squamulose as described, and so does the single ♀ from Herberton. A single ♀ from between Millaa and Innisfail has the tarsi simple. In a series of specimens from mountains (including Mt. Fisher) between Millaa Millaa and Ravenshoe, 5 ♀♀ have tarsi simple, 3 squamulose. Three ♀♀ from Longlands Gap all have simple tarsi. My single specimen from the western foot of Mt. Bartle Frere (the northeastern known limit of the species' range) is a ♂.

NOTONOMUS SAEPISTRATIUS Sloane

triplicatus Darlington 1953, p. 100 (new synonymy).

Sloane (1907, p. 364) described this species (Fig. 9) from Atherton, on the Atherton Tableland, North Queensland. I misinterpreted Sloane's description and re-described the species from Lake Barrine and Yungaburra, on the Tableland not far from the type locality. In 1957-1958 my wife, son, and I took a total of 8 more specimens of the species at Atherton, Yungaburra, and Lake Eacham. At Atherton, we found it only in patches of rain forest on the flat part of the Tableland along



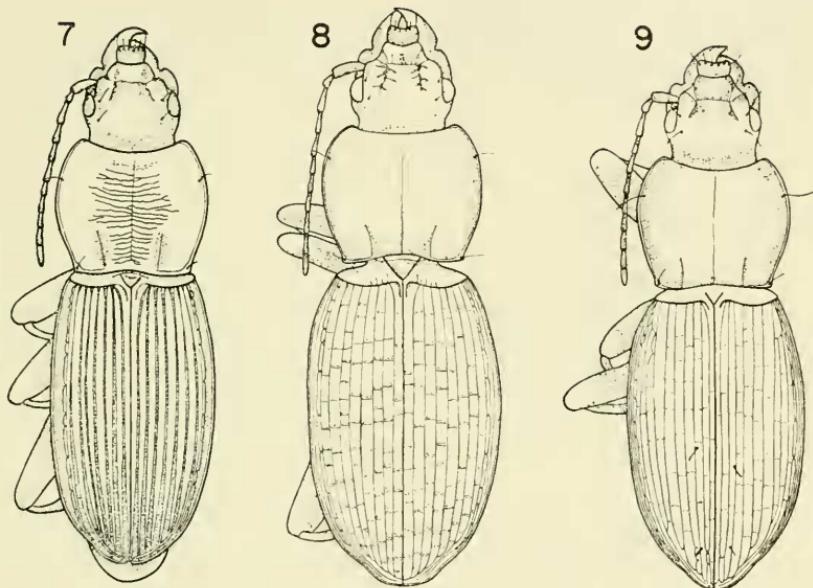


Fig. 1. *Notonomus transitus* n. sp.
Fig. 2. *Notonomus montellus* n. sp.
Fig. 3. *Notonomus dimorphicus* n. sp. (slender ♂).
Fig. 4. *Notonomus dimorphicus* n. sp. (♀).
Fig. 5. *Notonomus flos* n. sp.
Fig. 6. *Notonomus montorum* n. sp.
Fig. 7. *Notonomus ellioti* n. sp.
Fig. 8. *Notonomus masculinus* Darlington
Fig. 9. *Notonomus saepistriatus* Sloane

the road toward Mareeba. The species, therefore, seems to be uncommon, confined to a very limited area (a strip about 10 miles long) of the central Atherton Tableland. It apparently does not occur in the mountains west and south of Atherton, where it is replaced by *doddi*, and does not overlap the range of *masculinus*. In other words, these 3 strikingly different species seem to be allopatric. My 3 ♀♀ of *saepistriatus* all have narrow, unclothed front tarsi.

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